Magnetic Patterned Array Characterization with X-Rays

Beamline: X13A

Technique: Soft x-ray magnetic scattering

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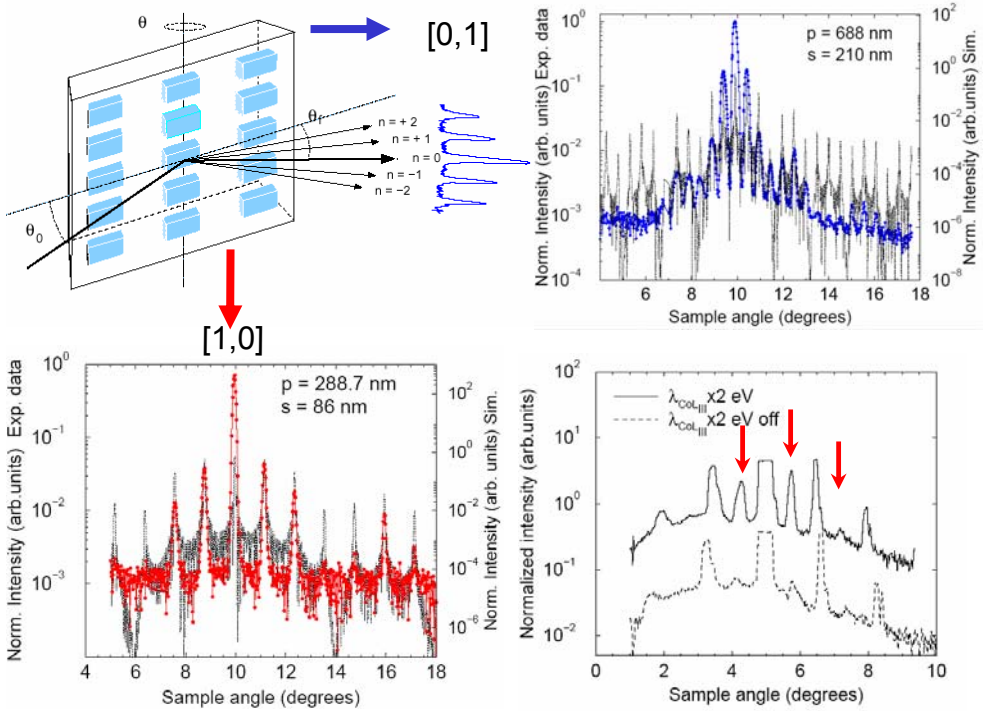
C. Sánchez-Hanke, et al. "Soft X-ray Resonant Scattering: An element-specific tool to characterize Patterned Arrays of Nanomagnets." IEEE transaction on magnetics, **39**, 3450 (2003).

Motivation: The increasing demand for magnetic random access memories (MRAM) with higher density and speed is driving a reduction in the size of individual magnetic data storage elements into the sub micron regime. The high quality of these patterned arrays of nanomagnets allows us to consider them as two-dimensional gratings to be used in diffraction experiments. Moreover the use of circularly polarized soft x-rays allows us to extract not only the charge information (size and period) but also magnetic information measuring the angular dependence of the magnetic circular dicroism.



(Top left) Experiment geometry showing different diffraction orders. (Top right, bottom left) sample scans showing diffraction orders along the [0,1] and [1,0] directions, easy and hard magnetization axis of the nanomagnets. (Bottom right) Presence of antiferromagnetic ordering in nanomagnets.

Results: The current X13A experimental set-up allows the study of patterned arrays of nanomagnets with fast switching (22 Hz) elliptically polarized soft x-rays obtaining charge and magnetic information averaged over the entire illuminated area of the sample. In the soft x-ray range treating the patterned arrays as 2D-gratings it is possible to reach up to the 12th diffraction order in the [0,1] direction (top-right), along the easy magnetization axis of the nanomagnets (blue line). The array's periodicity and the nanomagnets size was characterized using the Fraunhoffer theory (black continuous line). Making use of the difference between left and right elliptically polarized x-rays it is possible to extract the magnetic information of the nanomagnets. The bottom-right figure shows the presence of half order peaks between the charge diffraction orders. These half order diffraction peaks indicates the presence antiferromagnetic ordering between the nanomagnets close to remanence conditions.